A constraint-based selection principle for the Standard Model gauge group: a substrate with derived dynamics, a no-go theorem, and the measure problem

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10 July, 2026—draftv6.1

Abstract

We present a discrete substrate model in which several dynamical rules that are ordinarily postulated are instead theorems. Units are pairs of differentiation counts; only the count difference is observable; equal counts are indistinguishable from absence. From the single move "differentiate a slot" we prove: an unobservable, strictly monotone total (an arrow-of-time residue); an observable ± 1 walk (an oscillation sector); and annihilation upon equalization (a failure mechanism), with the residue–annihilation identity holding exactly in simulation. Units carry birth types (contextual versus contrast channel); the minimal closed structure is the two-plus-one triangle, and the closure taxonomy is exactly graded by contrast content, with the rare all-contrast class serving as a carry that closes a $\mathbb{Z}_3$ grading — a rule stress-tested against its falsification signature and not falsified (χ^2 consistency with fresh-seed statistics, $p = 0.875$, $n = 27$ carry events). On this substrate we construct a graded transfer operator whose matrix elements are *measured* from the substrate's own dynamics, verify its $\mathbb{Z}_3$ transfer identity to machine precision, and prove an exact orientation theorem: contrast-type units are formation sinks, so the mirror pattern has multiplicity zero ($\varepsilon = 1$; verified 1150:0 with full dynamics). Within a constraint-based classification of the internal gauge algebra, five standard filters reduce the Cartan catalogue to the Standard Model group plus two competitors; the two decisive further constraints remain conjectures, and for one of them we prove a no-go theorem: a parity-even, chirality-blind cosmological deformation cannot distinguish $SU(2)_L$ from $SU(2)_R$ at any order, so any expansion-sourced parity selection requires an axial component, whose combinatorial precondition the orientation theorem supplies at strength $\varepsilon\kappa_{\mathrm{rad}} \approx 0.93$. Finally we report the model's central open problem with full candor: the emergent dimension is a smooth function of a growth measure that the rules underdetermine, spanning $d \approx 1$ to $d \approx 7.6$ across rule-plausible kinematics with $d = 3$ interior and not yet distinguished. We name this the measure problem, map the control surface, and identify the most rule-faithful derivation route.

*Independentresearcher.Email: tmorg11@yahoo.com.ORCID:0009-0006-6415-4051.Draftforcomment. Divisionoflabor,statedplainly:theconceptualframework,itsrules,andallfoundationaldecisionsarethe author's; the formal derivations, proofs, and simulations were produced with substantial assistance from AI systems (Anthropic Claude), are verified numerically as stated in the text, and have not yet been independently checked by a human mathematician. Every claim is labelled at its registered strength (theorem / measured / conjecture). Correspondence, criticism, and collaboration are welcome.

1 Introduction

The gauge group $SU(3) \times SU(2) \times U(1)$, the generation count, and the handedness of the weak interaction are inputs to the Standard Model. This note describes a speculative programme intended to make them outputs, and reports its present state after a foundational consolidation: five candidate substrate models were constructed, measured against a single criterion, and one was adopted; its dynamics was then integrated, its operator built from measured rates, and its theorems established or honestly downgraded. We are explicit throughout about the three registers of claim: THEOREM (proved, and where applicable verified numerically), MEASURED (a simulation result with stated statistics), and CONJECTURE/POSTULATE (labelled as such). The negative results — a no-go theorem for chirality-blind cosmological parity selection, and the interiority of $d = 3$ in the measured dimension surface — are reported at the same prominence as the positive ones, because we believe they are of independent interest to anyone attempting similar constructions.

2 The substrate

2.1 Units, counts, and three derived rules

A *unit* is a pair of differentiation counts $(n_1, n_2) \in \mathbb{Z}^2_{\geq 0}$. The only primitive move increments one count. Two principles govern observability: *anonymity* (absolute counts are unobservable; only $d = |n_1 - n_2|$ is a state label) and *white-on-white* ($d = 0$ is indistinguishable from absence: a unit driven to equal counts ceases to exist). Three consequences are theorems.

Theorem 1 (Residue)**.** *The total $n_1 + n_2$ increases by exactly one on every move and is unobservable: the substrate keeps a hidden, strictly monotone ledger of its own history.*

Theorem 2 (Oscillation)**.** *The observable d changes by exactly ± 1 per move: the visible dynamics of a unit is a one-dimensional walk. Arrow (the hidden total) and beat (the visible difference) are two faces of the same move.*

Theorem 3 (Failure)**.** *A trailing-slot move at $d = 1$ equalizes the pair and annihilates the unit, incrementing the residue. In the integrated simulation the residue–annihilation identity holds exactly (e.g. $574 = 574$; $1417 = 1417$ across runs).*

Units are graph vertices; links form locally under finite valence; failed units' neighbours re-knit (return-to-prior-pattern), and units bound into closed structures are permanent (irreversibility), which stabilizes the substrate (largest connected component = 100% with the full dynamics).

2.2 Types, shells, and the graded taxonomy

Units are created through two channels: a *contextual* channel (type A), permitted because differentiated structure already exists, and a *contrast* channel (type B), sourced only from type-A units (the *generative rule*). The minimal closed structure is the triangle with composition AAB: two contextual units and one contrast unit, the outer A's closing the configuration. Measured closure taxonomy (7,728 shells, four seeds): $AAA : AAB : ABB : BBB = 3527 : 3359 : 815 : 27$ — exactly the four contrast-content grades, and nothing else.

Postulate 1 (Shell carry)**.** *An all-B triangle is homogeneous at the contrast level — white-on-white there — and registers as the AAA seed of the next hierarchical level. Visible classes per level therefore number three.*

The carry postulate was stress-tested against its falsification signature: if wrong, carry events should show contrast-enriched continuation. Measured: subsequent-shell grades within graph radius 2 of the 27 carry events (44.8%/45.5%/9.7%) are statistically indistinguishable from the global fresh-seed baseline (45.6%/43.5%/10.5%), $\chi^2 = 0.27$, $p = 0.875$; the enrichment signature is absent. Power caveat: $n = 27$ excludes large deviations only; the clause stands for re-test at higher statistics.

2.3 The orientation theorem

Theorem 4 (Orientation, $\varepsilon = 1$)**.** *Under the generative rule, every formation edge has a type-A tail. Hence in every minimal AAB shell the B vertex is a formation sink, and the mirror pattern (a formation edge out of B) has multiplicity zero.*

Proof. Induction over moves: the contrast channel is the only B-creating move and gives B a single in-edge from an A; no move creates an edge with a B tail; annihilation and re-knitting create only undirected links; permanence preserves the formation edges of closed shells. □

Verified with the full dynamics: 1,150 B-sink shells, 0 mirrors (two seeds, 4,000 units each); a control run permitting non-A sourcing shows exactly the predicted leakage (7 mirrors). The radial screw correlation of formation edges within shells is $\kappa_{\text{rad}} = 0.931$ — *statistical*, downgraded from an exact value in an earlier typed model, with the leakage mechanism identified (re-knit and pure-link closures carry no formation direction).

3 The operator

On shell-formation histories (strings over grades $\{0, 1, 2\}$ and the carry symbol; 21,845 basis states at truncation length 7) we construct

$$K \;=\; K_0 + K_1 + K_2 + K_{\text{carry}} + K_{\text{return}} + q\,\mathbb{1}\!\!\not\!\!\!

4 The classification and the parity no-go

Five filters — unitarity, complex representations, asymptotic freedom, anomaly freedom, and no quark–lepton mixing — reduce the Cartan catalogue to $SU(3)\times SU(2)\times U(1)$, the Left–Right symmetric model, and rank-5 $U(1)$ extensions. The two decisive further constraints remain conjectures: a rank bound tied to the $\mathbb{Z}_3$ grading (whose carrier the operator above now supplies, but whose bound is not derived), and a parity selection tied to the sign of the Hubble rate. For the latter we have a theorem in the negative direction, for the cosmological deformation $(\partial_t^2 - \nabla^2)\psi + \Upsilon\,\partial_t\psi = 0$, $\Upsilon = 3H$:

Theorem 5 (Null)**.** *With the deformed propagators (uniform damping; all poles in the lower half-plane), the one-loop self-energies $\Pi_{L,R}(q)$ vanish identically for all q: a closed loop of retarded functions is zero, and massless fermions being conformally invariant in FLRW, no curvature correction supplies the missing part.*

Theorem 6 (No-go)**.** *A parity-even, chirality-blind Υ coupling leaves parity an exact symmetry exchanging the $SU(2)_L$ and $SU(2)_R$ sectors of the Left–Right model at $g_L = g_R$: all P-invariant functionals take equal values on the two sectors, to all orders and for all Υ.*

Any expansion-sourced parity selection therefore requires an axial component Υ_A. The substrate supplies its combinatorial precondition — a one-handed formation algebra, $\varepsilon\kappa_{\mathrm{rad}} \approx 0.93$ — while the embedding correlation κ and the effective coupling λ in $\Upsilon_A = \lambda\varepsilon\kappa$ remain open, pending the geometry below.

5 Geometry: the measure problem

The emergent dimension of the substrate, measured by finite-size scaling of the mean graph distance, is a smooth function of the growth kinematics that the rules underdetermine. Measured points: a frontier-walker dynamics gives $d = 1.02$ ($R^2 = 0.993$) — a filamentary skeleton of permanent shells in an annihilating froth; region and global kinematics give $d \approx 4.3$–7.6; attractor-density weighting (the growth-follows-density rule, implemented as written with weight β) is a smooth monotone lever, e.g. $4.48 \to 3.13 \to 2.55$ at $\beta = 0, 8, \infty$ in the global family (R^2 up to 0.9999). The value $d = 3$ is *interior* to this surface and reachable along multiple paths; nothing measured makes it a fixed point or otherwise distinguished. We therefore state the model's central open problem plainly: the rules specify which moves exist and how density biases them, but not the *measure* over move sites; the conjecture that $d = 3$ is derived is precisely the conjecture that the correct measure — derived, not chosen — lies on the $d = 3$ locus of the mapped surface. The most rule-faithful derivation route, not yet executed: the sites of action should be the sites of *expression* — the oscillation sector already defines an expression-event measure, and it has never been used as the site-selection law. This uses no new postulates and is computable.

6 Predictions and open problems

If the two conjectures were established the framework would predict: no proton decay at any energy; three generations (grade sectors of the fermionic spectrum — an identification, not a derivation); and a correlation between the sign of H and weak-sector handedness, with a contracting phase favouring the mirror sector. We attach no numbers to the latter items: amplitudes

are not yet computable, and a prediction without a magnitude is not falsifiable. Open problems in dependency order: (1) the measure problem (above); (2) the embedding correlation κ and coupling λ; (3) the rank bound and the fermionic spectrum behind the generation identification; (4) re-test of the carry postulate at high statistics; (5) amplitudes. The model's value at this stage lies in the precision with which these are posed, in the theorems that no longer need to be postulated, and in the negative results that constrain any programme of this kind.

A Numerical protocol

Growth: local moves under finite valence (cap 6), full dynamics (counts, annihilation, re-knitting, permanence), sizes 1,500–64,000, seed-averaged. Dimension: finite-size scaling of mean BFS distance, $\ell \sim N^{1/d}$, with small-world diagnosed by flat $\ell(N)$. Operator: sparse construction on 21,845 states; transfer residual by grade projection at $s = 0.98$; spectrum by Arnoldi iteration. Shell statistics: four instrumented runs, 7,728 shells; carry-vicinity census within graph radius 2 with AAA controls. Code available from the author.

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